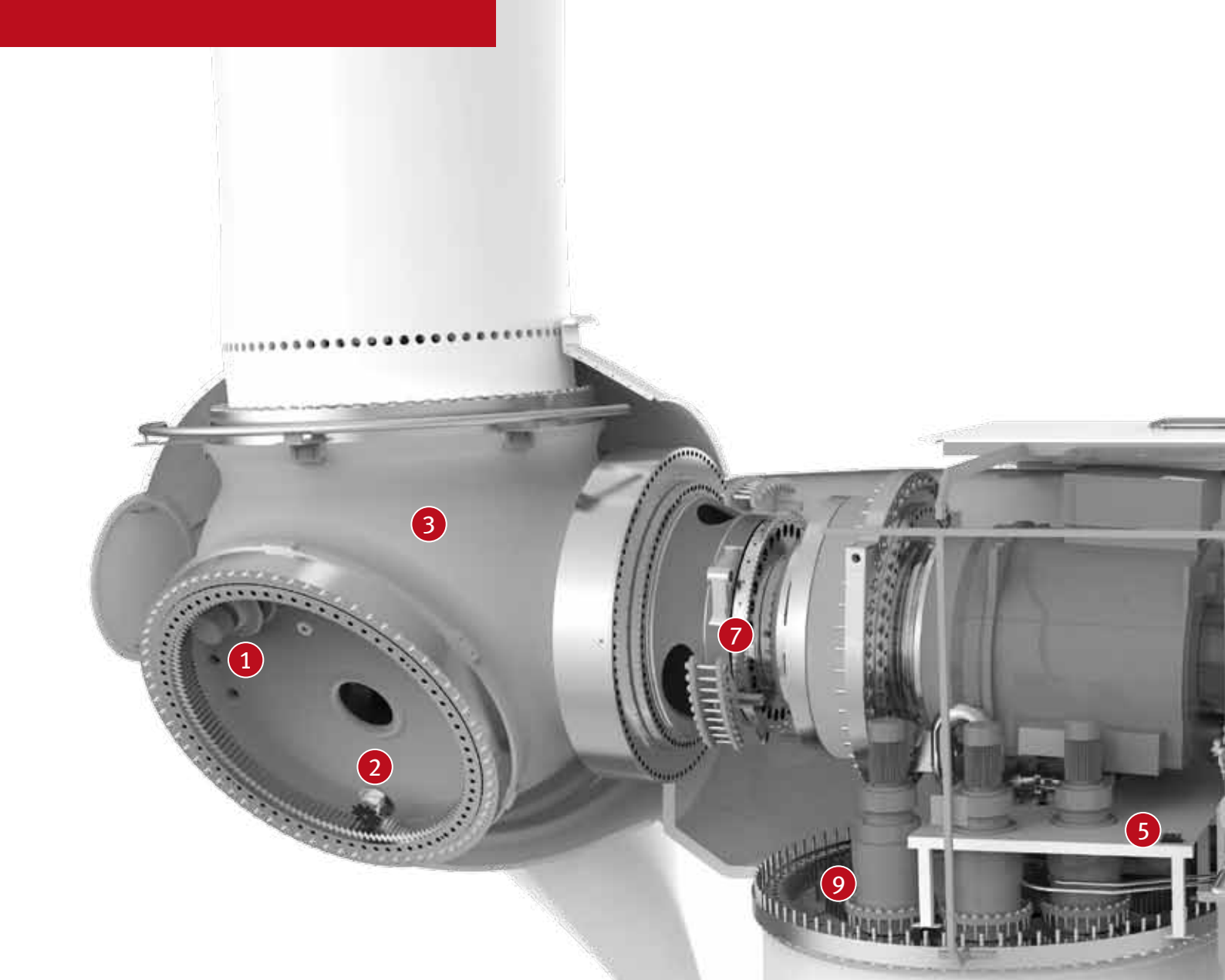
LENORD +BAUER

... automates motion.

SENSORS AND CONTROL SYSTEMS IN WIND TURBINES



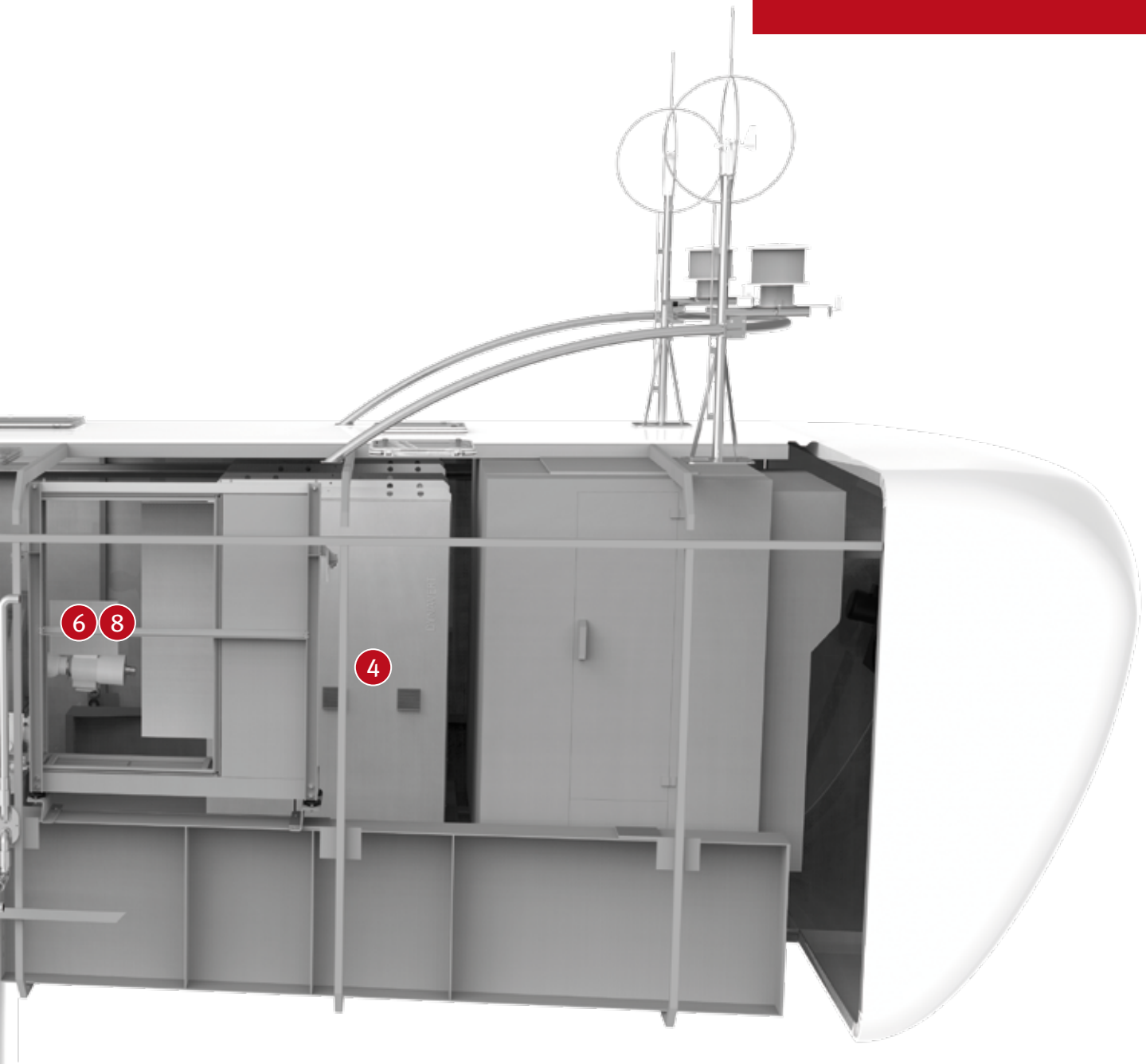
Sensors and control systems from Lenord + Bauer

15 years of experience and more than 30,000 installations worldwide

Modern wind turbines are masterpieces of the art of engineering. They defy sub-tropical heat, arctic cold, dirt, humidity and salt mist, as well as the continuous vibration in the nacelle. At the same time they operate around the clock, 365 days a year. For this reason wind turbine manufacturers – just like the manufacturers of rail vehicles – are among the most demanding customers in the area of automation technology.

Lenord + Bauer has been tackling this challenge for decades! Irrespective of whether measurement, control or regulation: our robust automation products and magnetic sensors provide optimal prerequisites for the complete monitoring and the safe operation of all rotating components in a wind turbine.

With this brochure we would like to give you an overview of the products from our overall portfolio that are proven in wind turbines. In principle, all products can be adapted to the specifications for your individual installation. We would be pleased to advise you in a personal meeting.



Source: Wind-to-Energy GmbH, Rostock

Diverse applications – one system supplier
Lenord + Bauer

① Pitch motor: position detection and speed measurement
② Blade bearing: position detection
③ Pitch system: control of rotor blade position
④ Sub-system: control of the temperature management
⑤ Tower: measurement of the tower oscillation
⑥ Slip ring: position detection and speed measurement
⑦ Powertrain: position and speed measurement on the main shaft
⑧ Generator: speed measurement
⑨ Azimuth: position detection of the nacelle

Source: Wind-to-Energy GmbH, Rostock

Pitch motor
Position detection and speed measurement

For optimal energy yield, pitch-controlled wind turbines do not just align their hub to suit the wind speed and direction, but also their blades.

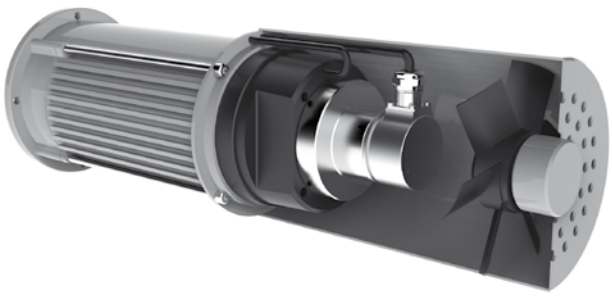
Lenord + Bauer absolute rotary encoders with integrated bearings are proven in the exact adjustment of the blade position, as they can be used straightforwardly even in case of extreme ambient temperatures, humidity, dirt, condensation or heavy vibration. The exact position of the rotor blade is acquired on the B-side of the rotor blade adjustment motor.

Advantages of the absolute rotary encoders from Lenord + Bauer

:: Robust, magnetic sensors
:: High resolution
(max. 16 bits single turn, 28 bits multiturn)
:: Suitable for offshore operation as well as applications in cold and hot climates
:: Optionally available with digital SSI, CANopen or PROFIBUS-DP and analogue 0 to 10 V or 4 to 20 mA interfaces
:: Durable, reliable technology
:: Maintenance-free over the long-term
:: IP 67 variants available

Our recommendation: Absolute rotary encoder GEL 2037

:: 25-bit resolution (13 bits single turn, 12 bits multiturn)
:: SSI
:: Redundant measuring system with integrated, separate resolver
:: Robust design compliant with IP 67
:: Heavy-duty flange for high bearing loads
:: Maintenance-free thanks to mechanical gear
:: Extended temperature range -40 °C to + 85 °C



Alternative products for this application:
GEL 2035 and GEL 235 series

Source: Wind-to-Energy GmbH, Rostock

Pitch motor
Incremental position detection and speed measurement

The incremental rotational speed sensors from Lenord + Bauer are proven in the acquisition of the rotational speed of the rotor blade adjustment motor; these sensors scan a target wheel connected to the motor shaft. The sensors are significantly smaller than absolute rotary encoders with integrated bearings, but just as robust in relation to ambient effects. As they scan the toothed wheel contactlessly, they operate completely maintenance-free and wear-free.

Redundant feedback systems can be realised easily by scanning a target wheel using two or more sensors.

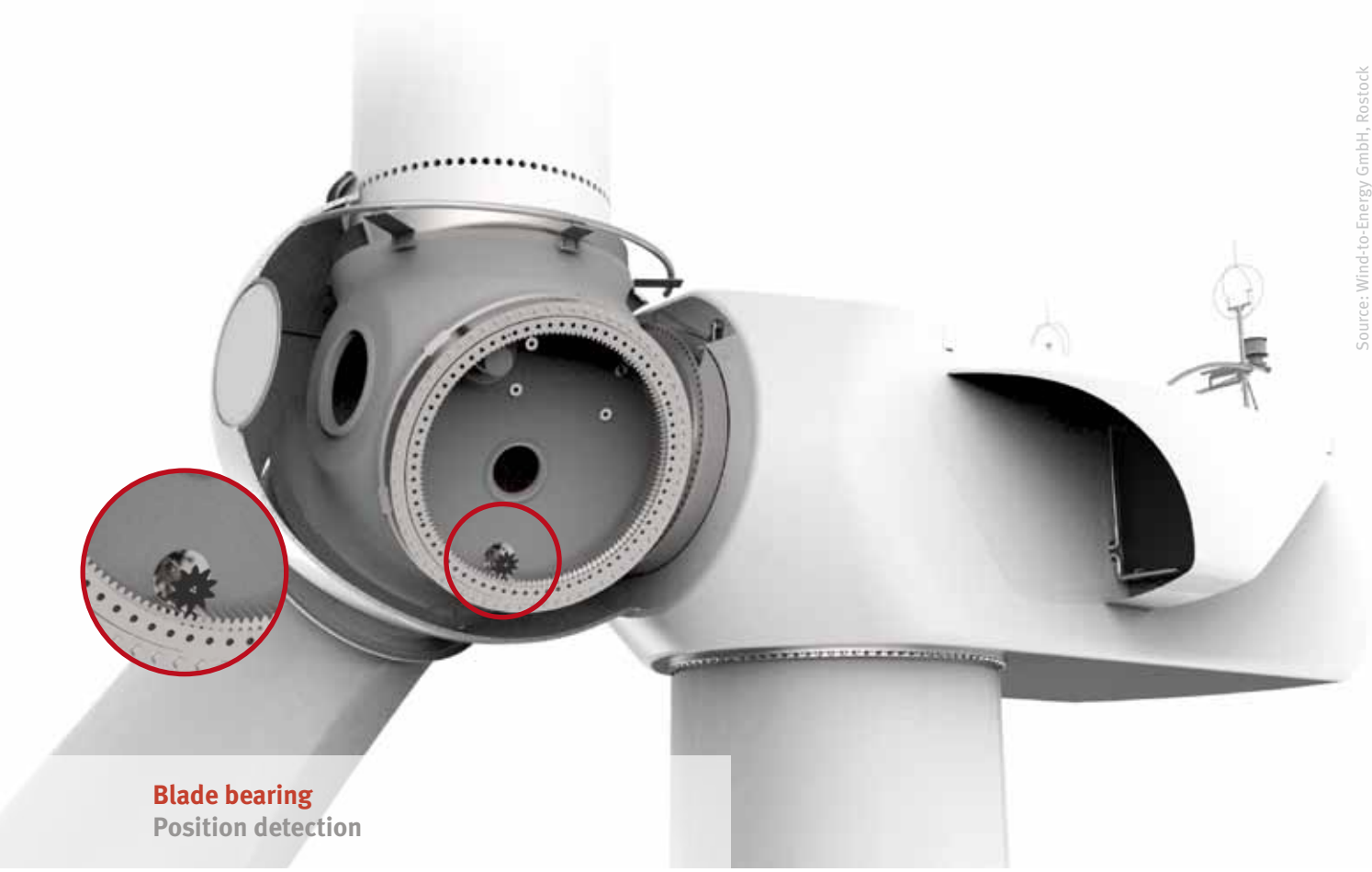
Advantages of the speed sensors from Lenord + Bauer

:: Robust, magnetic sensors
:: High accuracy in a speed range of 0 to 25 kHz
:: Suitable for offshore operation as well as applications in cold and hot climates
:: Optionally available with either HTL or TTL signal output
:: Completely wear-free and maintenance-free
:: Robust design compliant with IP 68

Our recommendation: Encoder kit GEL 248

:: Magnetic scanning of toothed wheels, racks or slotted discs
:: Target wheels: modules 0.7 to 4.0 can be scanned
:: Extended temperature range -40 °C to +120 °C
:: Data acquisition at standstill
:: Acquisition of slow movements without loss of pulses
:: Particularly compact design ideally suited to use in limited space envelopes

Alternative products for this application:
GEL 247 series



Source: Wind-to-Energy GmbH, Rostock

Blade bearing
Position detection

In addition to rotational speed and position acquisition on the pitch motor, it is possible to determine the rotor blade position almost free of play using a rotational speed acquisition at the root of the blade. For this purpose an absolute rotary encoder with integrated bearings is fitted with a flexible flange; this encoder engages directly with the teeth on the blade bearing.

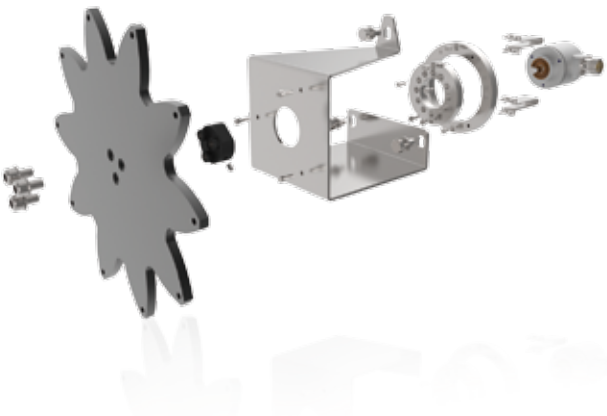
The advantage of this variant is that direct acquisition at the root of the blade prevents errors in the measured values due to an intermediate gearbox.

Advantages of the absolute rotary encoders from Lenord + Bauer

:: Robust, magnetic sensors
:: Complete system available comprising bracket, flexible flange, rotary encoder, target wheel and cable set
:: High resolution (max. 16 bits single turn, 28 bits multiturn)
:: Suitable for offshore operation as well as applications in cold and hot climates
:: Optionally available with digital interface SSI, CANopen or PROFIBUS-DP and analogue interface 0 to 10 V or 4 to 20 mA
:: Optionally available as IP 67 or IP 69 K variant

Our recommendation: Absolute rotary encoder GEL 235

:: 28-bit resolution (16 bits single turn, 12 bits multiturn)
:: Accuracy better than 0.09 °, high linearity
:: Dew-point resistant
:: Shock and vibration-resistant
:: Extended temperature range -40 °C to +105 °C
:: Heavy-duty flange for high bearing loads
:: Maintenance-free over the long-term thanks to mechanical gear
:: Optionally available with digital interface SSI, EtherCAT, CANopen or PROFIBUS-DP and analogue interface 0 to 10 V or 4 to 20 mA



Alternative products for this application:
GEL 2035; GEL 2037

Source: Wind-to-Energy GmbH, Rostock

Pitch system
Control of rotor blade position

Modern wind turbines use complex, cascaded control loops to efficiently control the installation. An important sub-system here is the control system for the rotor blade position.

The compact control systems from Lenord + Bauer have been proven in this demanding application over the last 15 years. They have a compact design, a wide range of interfaces and are suitable in particular for the adverse temperature and environmental conditions in the nacelles. They are used both for condition monitoring and for the control of the blade angle.

Advantages of the compact control systems from Lenord + Bauer

:: Compact construction without fan
:: Due to the use of lacquered printed circuit boards, suitable for offshore operation as well as applications in cold and hot climates
:: Shock and vibration-resistant
:: Weather-resistant, integrated display with membrane keyboard
:: Comprehensive fieldbus interfaces
:: Remote service web function
:: More than 20,000 installations worldwide

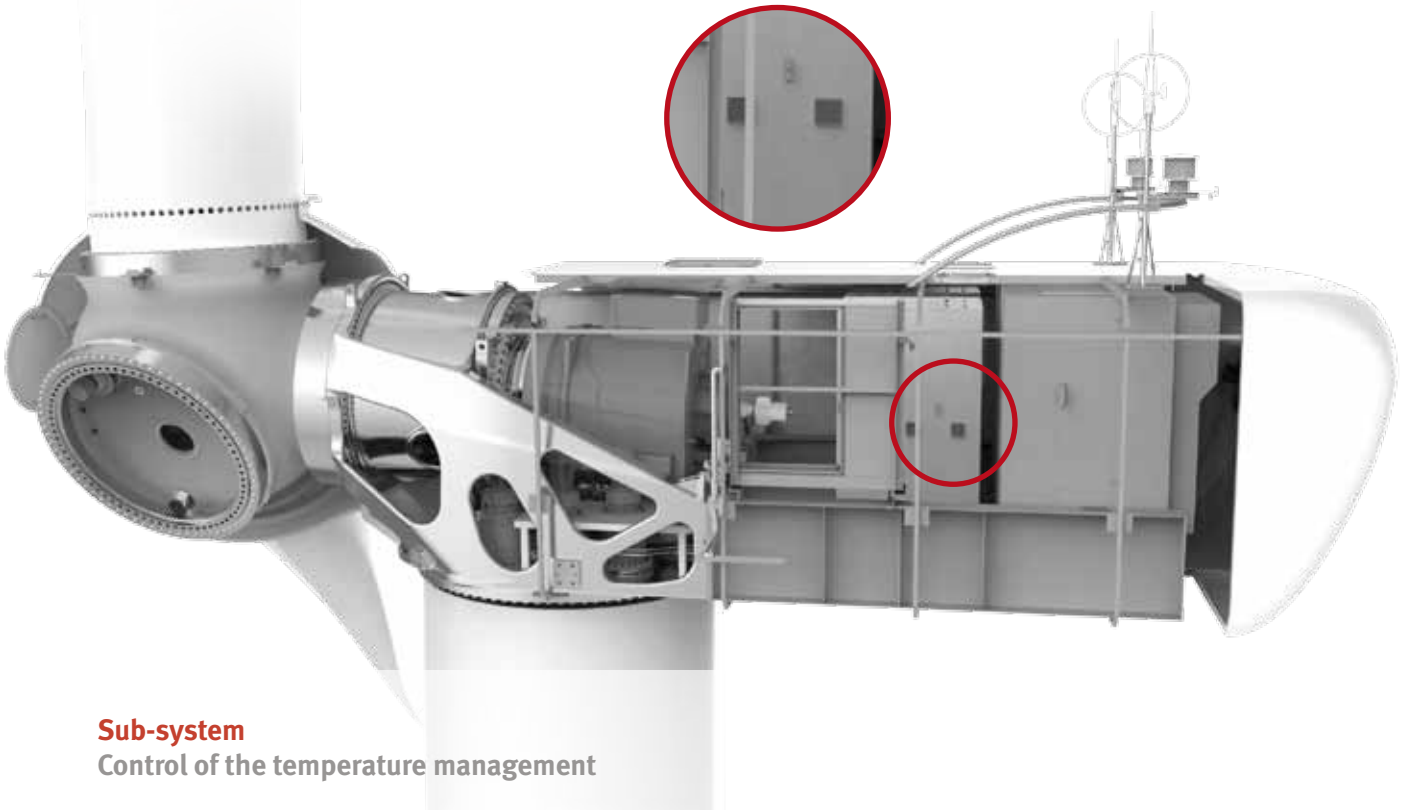
Our recommendation: Control system GEL 8251

:: Integrated, freely programmable PLC
:: Extended temperature range from -20 °C to +70 °C with maximum atmospheric humidity of up to 95 %
:: 30/15 digital IN/OUT, 3/3 analogue IN/OUT, 4 x PT100
:: 6 absolute encoder inputs (SSI) for the connection of rotor blade and/or pitch motor rotary encoders
:: 2 CANopen interfaces on board

CODESYS

EtherCAT CANopen PROFIBUS

Alternative products for this application:
GEL 8230 and GEL 8232 series



Source: Wind-to-Energy GmbH, Rostock

Sub-system
Control of the temperature management

Modern wind turbines for generating energy are proven not only in moderate climatic zones, but in the meantime also in sub-polar and sub-tropical regions. However, these so-called hot or cold climate locations require active temperature management that protects the power electronics and also gears or energy stores against failures and damage.

The fieldbus controller series from Lenord + Bauer was specially designed for this application and is available with customised software for decentral temperature management in wind turbines.

Advantages of the control system from Lenord + Bauer

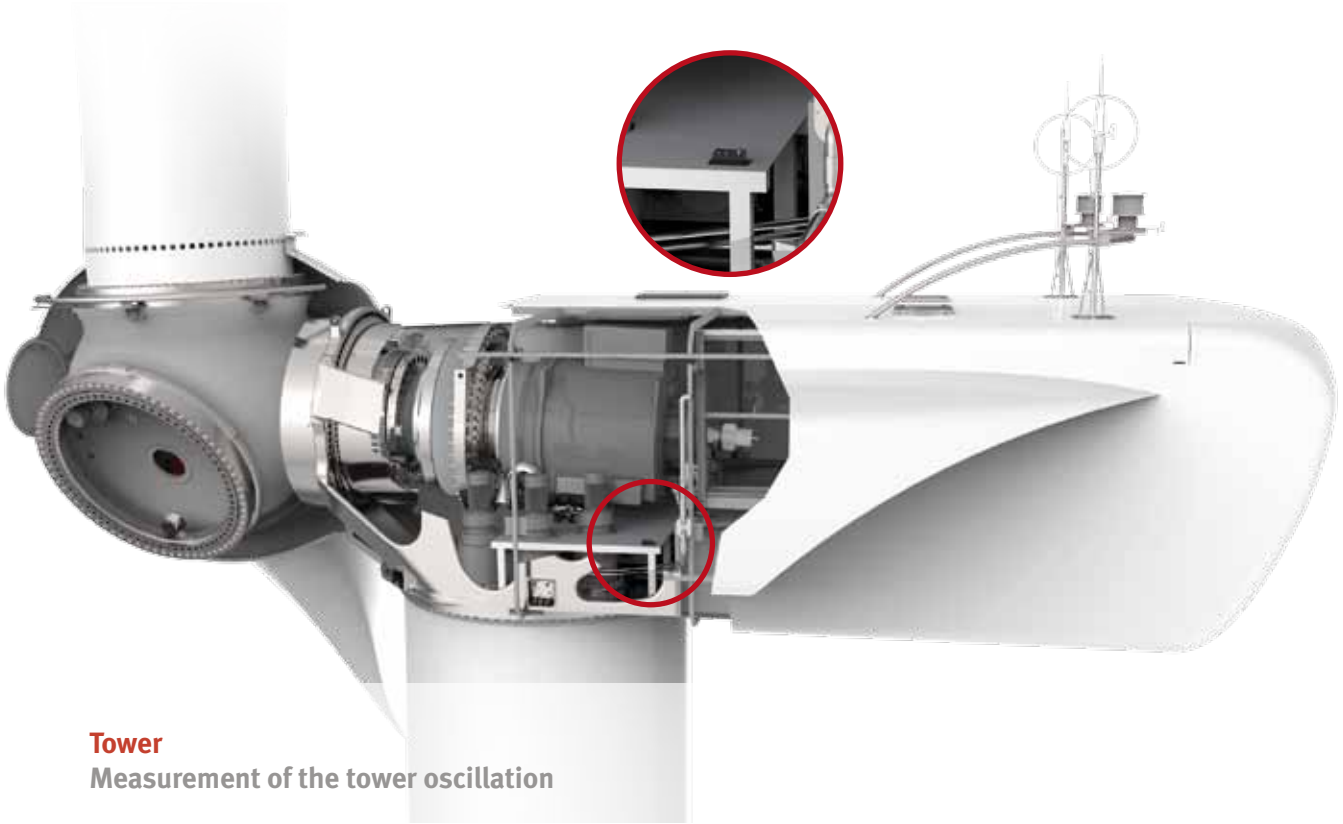
:: Can be used decentrally
:: Extended temperature range -50 °C to +85 °C
:: Dew-point resistant
:: Suitable for hot climate and cold climate
:: High shock and vibration resistance
:: Compact, slender design for mounting on top hat rails
:: Installation-specific software variants
:: Software parameters can be set using Windows service tool

Our recommendation: Fieldbus terminal controller GEL 8500

:: CANopen (CiA 301 + CiA 401)
:: 6/6 digital IN/OUT, 2 x 230 V AC OUT, 4 x PT100
:: Operating temperature of -40 °C to +85 °C
:: Maximum installation altitude 3,000 m
:: USB service port
:: Integrated high-power MosFETs for the direct operation of loads or contactors

CANopen

Alternative products for this application:
GEL 8230B202; GEL 8232B202



Source: Wind-to-Energy GmbH, Rostock

Tower
Measurement of the tower oscillation

Despite careful design and workmanship, oscillations occur during the operation of wind turbines; these oscillations continuously subject the structure and materials to mechanical stress.

Lenord + Bauer has developed a special sensor that measures the tower oscillations in real time and transmits the measurements via a CANopen interface to the control system for the installation. If the stipulated limits are exceeded, the installation can be shut down via two safety relays integrated into the measuring device. Particularly in installations with safety-related requirements imposed by the authorities, the tower oscillation monitor reliably acquires dangerous resonances and reduces the residual risks.

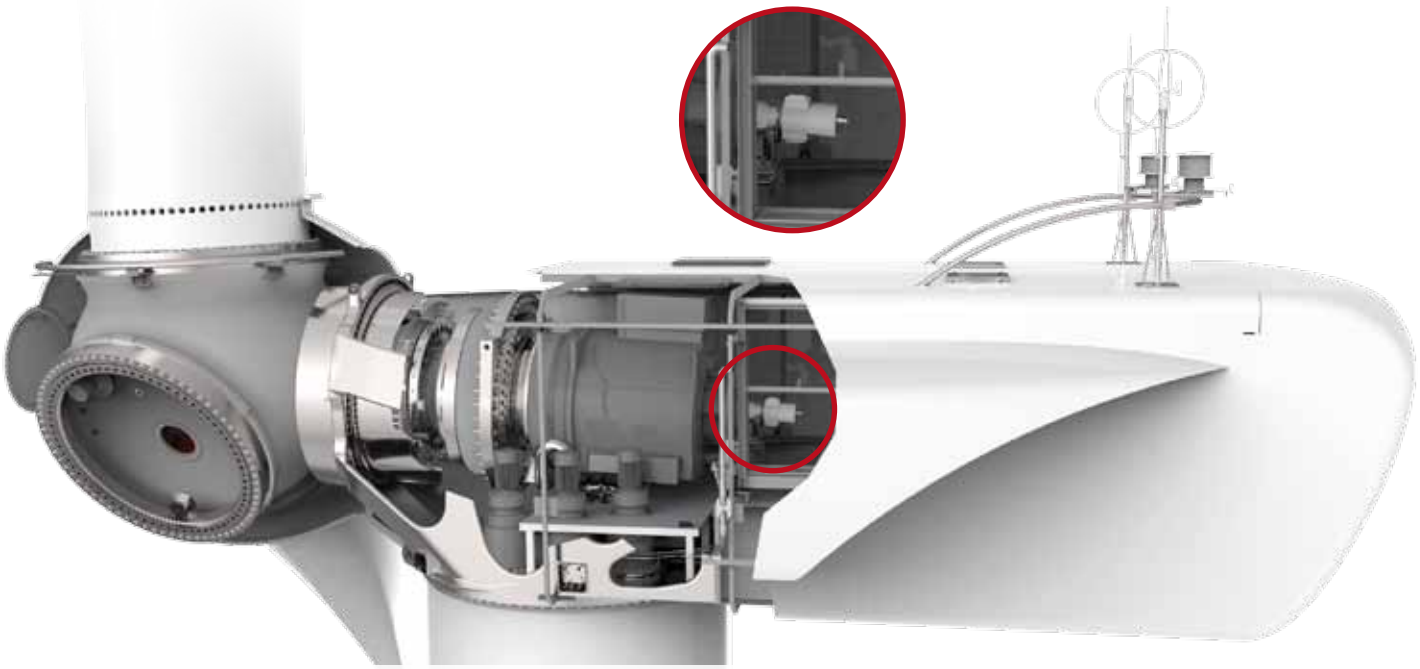
Advantages of the tower oscillation monitor from Lenord + Bauer

:: Can be integrated into existing safety systems
:: Mature, micro-electro-mechanical system (MEMS acceleration sensors)
:: Robust sensors that are not subject to any ageing whatsoever and that operate completely maintenance-free and wear-free
:: Straightforward integration in EtherCAT or CANopen networks
:: Dew-point resistant, compact design
:: Redundant measuring system due to comparison of two acceleration sensors integrated into the measuring device.

Our recommendation: Tower oscillation monitor GEL 3011

:: Suitable for safety applications with requirements in accordance with Performance Level d as per DIN EN ISO 13849 (eqivalent to SIL2 as per DIN EN 61508)
:: Two mechanically interlocked safety relay outputs
:: Measuring range ± 15 m/s² (1.5g) with a resolution of ±0.01 m/s²
:: Frequency range 0 to 10 Hz
:: Three measuring directions aligned at an angle of 90° to each other
:: Protection class IP 67
:: Operating temperature range -40 °C to +85 °C
:: Installation altitude up to 4,000 m
:: Available with CANopen interface

Alternative product for this application:
GEL 3010



Source: Wind-to-Energy GmbH, Rostock

Slip ring
Position detection and speed measurement

Modern wind turbines use slip rings to transmit data and energy between the hub and nacelle. As the slip ring rotates in synchronism with the rotor shaft, the rotor hub position and rotational speed can be acquired directly on the slip ring using a rotary encoder.

The series GEL 290 incremental rotary encoders are proven in this application. Due to the flexible configuration options for incremental and absolute rotary encoders, along with the various bus covers, it is possible to realise with little effort multiply redundant tandem encoders for monitoring the rotational speed of the drive train.

Advantages of the tandem encoders from Lenord + Bauer

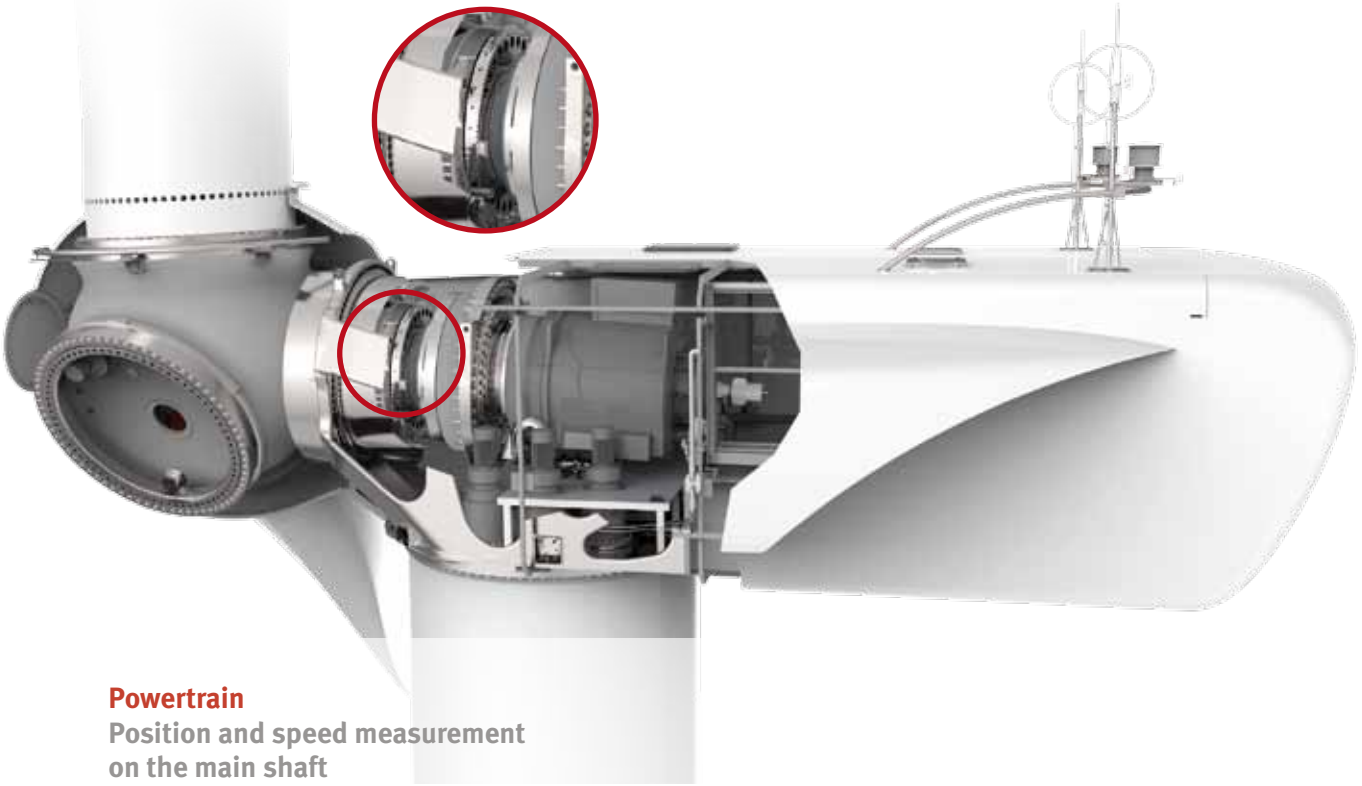
:: Modular design makes possible real redundancy as well as the acquisition of different measured parameters
:: Acceleration, rotational speed and position acquisition directly at the slow rotor shaft
:: Various fieldbus interfaces available
:: High-resolution, incremental output for evaluation in the wind turbine's safety system
:: Overspeed detection
:: Maintenance-free, durable operation in harshest conditions due to robust, magnetic sensors

Our recommendation: Tandem encoder GEL 290

:: Combination of incremental encoder with integrated bearings from the GEL 292 series with a GEL 235 absolute encoder or, alternatively, a GEL 293 incremental encoder
:: Optimised installation length due to modular design
:: High-resolution with up to 266,240 pulses per revolution
:: Integrated, highly elastic, torsionally stiff coupling
:: Extremely high angular acceleration
:: Robust design compliant with IP 66

EtherCAT® CANopen PROFINET

Alternative products in this application:
GEL 293, GEL 235, GEL 208



Source: Wind-to-Energy GmbH, Rostock

Powertrain
Position and speed measurement on the main shaft

As an alternative to drive train monitoring on the slip ring, the rotor hub position, the rotor pin locking position and the rotor rotational speed can be acquired by scanning a ferro-magnetic slotted disc permanently connected to the rotor shaft.

The advantage of this mounting position directly on the drive train is that acquisition errors cannot be caused by an intermediate coupling. The incremental speed sensor GEL 2495 is proven for the measurement; this sensor generates two completely separate, redundant rotational speed signals with a high number of pulses or high resolution.

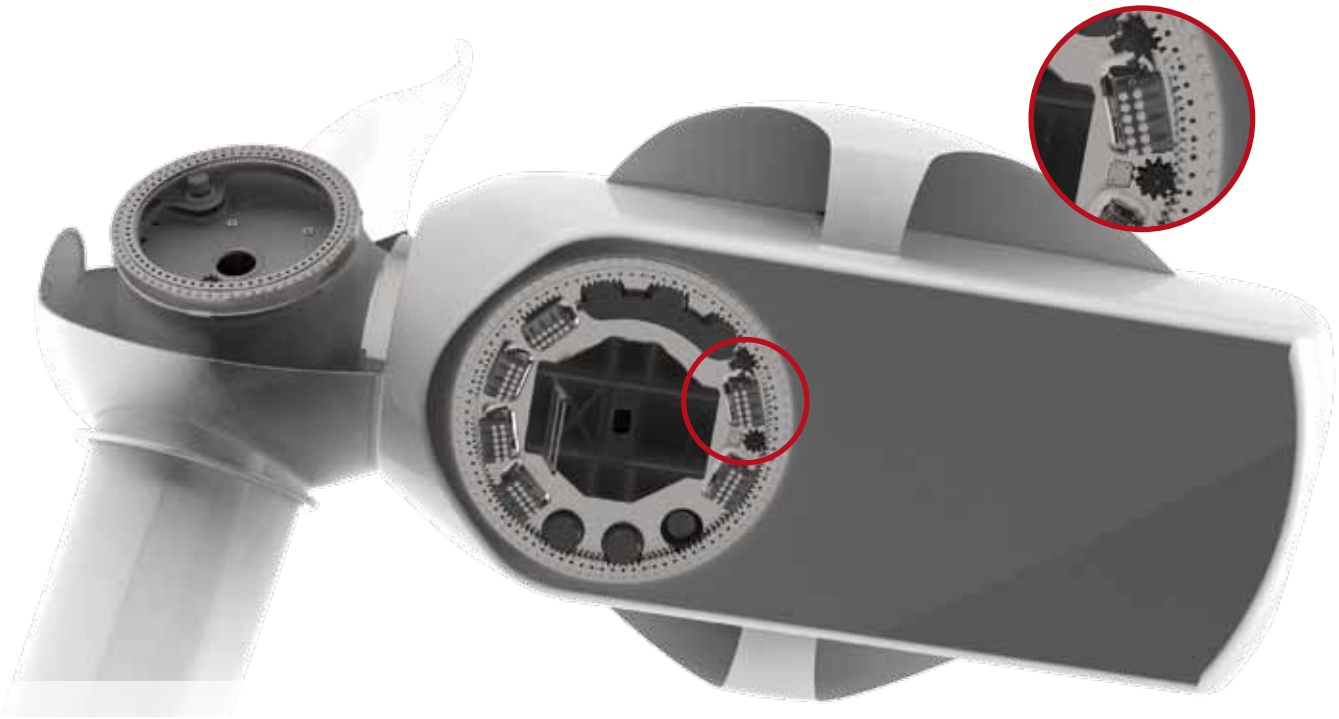
Advantages of redundant speed sensors from Lenord + Bauer

:: The magnetic sensors do not age
:: Redundant, incremental measuring system
:: High-resolution measurement of 4096 or 8192 pulses per 360°
:: The contour disk used as the measuring scale is bolted directly to the wind turbine's rotor shaft free of play
:: Thanks to redundant installation monitoring it is possible to shut down the wind turbine at any time in case of overspeed
:: A reference signal makes it possible to move to the rotor pin locking position

Our recommendation: Speed sensor GEL 2495

:: Up to 8,192 pulses per turn
:: Accuracy ± 0.05 °
:: High shock and vibration resistance
:: Dew-point resistant
:: Extended temperature range -40 °C to +85 °C
:: Robust design compliant with IP 67

Alternative products for this application:
GEL 247, GEL 248



Source: Wind-to-Energy GmbH, Rostock

Azimuth

Position and speed measurement on the main shaft

The exact tracking by the nacelle of changing wind directions is a crucial factor for optimal energy yield. The central element here is the toothed azimuth bearing that connects the nacelle to the tower. It is therefore ideally suited to the precise acquisition of the rotational speed and position of the nacelle.

Lenord + Bauer has developed a measuring system especially for this application; in addition to an absolute rotary encoder, this system comprises a bracket, flexible flange, target wheel and cable set.

Advantages of the absolute rotary encoders from Lenord + Bauer

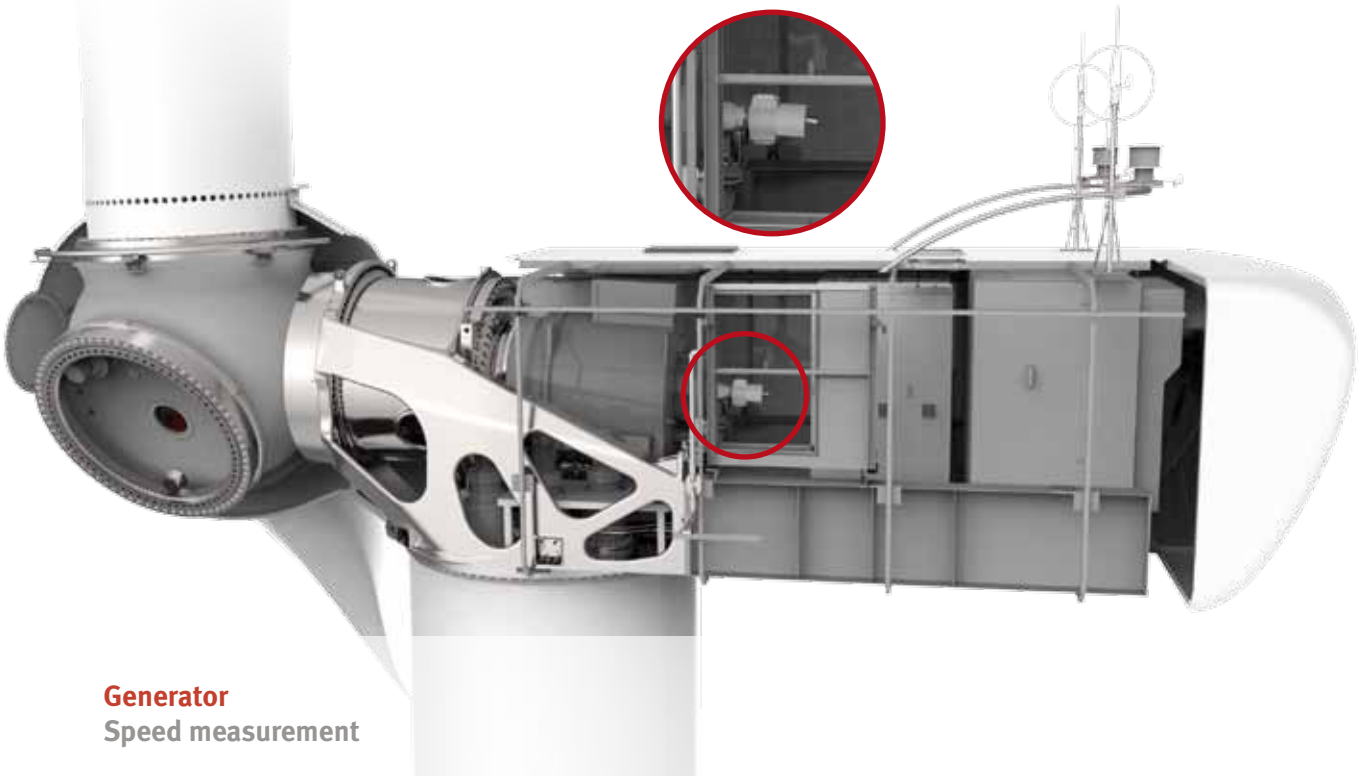
:: High external shaft loads are possible due to optimised bearings
:: Robust, magnetic sensors
:: High resolution (16 bits single turn, 28 bits multiturn)
:: Suitable for offshore operation as well as applications in cold and hot climates
:: Optionally available with digital interface SSI, CANopen or PROFIBUS-DP and analogue interface 0 to 10 V or 4 to 20 mA
:: Maintenance-free over the long-term in single turn and geared multiturn operation
:: Optionally available as IP 67 or IP 69 K variant

Our recommendation: Absolute rotary encoder GEL 235

:: 16 bits single turn, 12 bits multiturn
:: Accuracy better than 0.09 °, high linearity
:: Temperature range -40 °C to +105 °C
:: Complete system available comprising bracket, flexible flange, rotary encoder, target wheel and cable set

EtherCAT CANopen PROFIBUS

Alternative products for this application:
GEL 2035, GEL 2037



Source: Wind-to-Energy GmbH, Rostock

Generator
Speed measurement

To convert mechanical power into electrical power, wind turbines use three-phase generators with mains converters. To ensure high mains quality with variable rotational speed operation, the rotor speed is acquired continuously and processed in a feedback system.

The incremental rotary encoders from Lenord + Bauer are particularly suitable for the reliable acquisition of the generator speed.

Advantages of incremental rotary encoders from Lenord + Bauer

:: Integrated, highly elastic, torsionally stiff coupling
:: The magnetic sensors do not age
:: Extremely shock and vibration-resistant
:: Dew-point resistant
:: High number of pulses of up to 266,240 increments per turn
:: Insulated construction

Our recommendation: Rotary encoder GEL 293

:: Operating temperature range -20 °C to +85 °C
:: Storage temperature range -40 °C to +105 °C
:: Various output signal patterns possible
:: Maintenance-free over the long-term
:: Suitable for offshore, cold climates and hot climates

Alternative products for this application:
GEL 247, GEL 248

Customer-specific products and solutions

For more than 15 years Lenord + Bauer has been supplying the manufacturers of wind turbines. More than 20,000 control systems and countless sensors are in continuous use in a very wide range of climate zones worldwide.

Many of these products are customer-specific solutions we have adapted to the individual requirements of different wind turbine manufacturers. Along with software modifications, different interfaces or cable outlets, these sensors and control systems differ from our standard range to some extent even in their electronic components.

Due to our high level of vertical integration, we are able to quickly develop customer-specific products and solutions. Call us. We would be pleased to talk to you about custom solutions for your application.

Hardware

:: Basic development
:: 16/32 bit micro controller, power PC
:: Analogue and digital technology
:: Fieldbus interfaces
:: Housing technology

Application

:: Creation of control concept
:: Fieldbus concept
:: Environmental conditions
:: Interface definition

Design

:: Circuit diagram layout
:: Printed circuit board layout
:: EMC design
:: Housing technology
:: Component type test

Software

:: Operating system
:: Runtime system (e.g. CODESYS)
:: Application software
:: Operating software
:: Web technology

Communication

:: Modbus TCP

② Blade bearing: position acquisition

⑤ Tower: measurement of the tower oscillation

Your contact at Lenord + Bauer

For new developments and/or further developments you will find the right contact for your projects in Lenord + Bauer. We offer you our know-how and our support.

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